

## **AC 2008-1040: RISK ASSESSMENT OF A MECHANICAL ENGINEERING DEPARTMENT**

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# Risk Assessment of a Mechanical Engineering Department

## Introduction

In the spirit of continuous improvement, the Mechanical Engineering Department at Ohio University initiated a "risk assessment" process in the Fall of 2006 to take an open and honest look at all aspects of our department. Risks are potentially undesirable events, and examples of risks that are possible in a mechanical engineering department include extended sick leave for technical staff or faculty, a hiring freeze due to budget cuts, purchasing card restrictions due to misuse by University personnel, a faculty member leaving for industry mid-year, and the adverse reputational effects of misleading reporting of events in a student newspaper.

Although you may think that a risk assessment can only be done by a large department with lots of resources, that is not the case. Our department has about 250 undergraduates, 30 graduate students, 12 full time faculty, and three staff members. There are two research centers under the department, and overall the department and centers are involved in several million dollars worth of funded research. Our campus is primarily residential and is located in a small town.

Ohio University is similar to most universities in that we have a division of Safety and Risk Management that addresses risks on the university level, but this division does not deal with department-level risks. When we initiated our risk assessment, we were not able to find published examples of engineering department risk assessments for guidance. Department-level risk assessments were addressed in a talk by Ann Franke of Wise Results LLC, in which she identifies the main campus risk categories as: Financial, Operational, Life Safety, Compliance, and Reputational. Importantly, she identifies several risks to consider at the departmental level, including<sup>1</sup>:

- Teaching risks (poor teacher/student boundaries, bias or fraud in grading, harassment, injury in classroom or laboratory, targeted violence against a professor)
- Research risks (loss of research data or specimens, misuse of grant money, data fabrication, plagiarism, failed collaborations)
- Other risks: email privacy risks (non-university accounts), unfair student discipline, discrimination, plagiarism, embezzlement, tenure denial complications and lawsuits, loss of computer data, field trip accidents, suicide, etc.

Operationally, Ann Franke advises to take a broad view of what could go wrong, focus on small steps for improvement, get help, follow up, adjust and stick with it for the long term.

Though not focused on college teaching, Dunklee et al in "A Primer for School Risk Management" identify the following relevant cases where school employees were found in the courts to be negligent<sup>2</sup>:

- For inadequately warning students about experiments, machinery or equipment.
- For assigning tasks that exceed the skill level of employees or students
- For not following the syllabus
- For insufficient safety training and inadequate enforcement of safety rules and regulations
- For insufficient supervision

Special situations like co-op education, field trips, and service learning<sup>3</sup> also present risks, as addressed by The National School-to-Work Office in a 1998 publication, *Managing the Risks of Work-based Learning: A Resource Guide*.

## **Mechanical Engineering Department Risk Assessment Process**

Using the fundamentals of risk assessment, along with the guidance from the literature concerning academic and campus risks, we embarked on our own risk management process. A risk assessment is the obvious first step in a risk management approach, and even on its own it is very important because it can allow potential dangers that previously were known to only a few people to be brought to the awareness of others. The risk management approach often used in business and industry combines the assessment with appropriate management plans to eliminate or control the risks. The risk management approach is not just a one-time event - if fully embraced it can change the way an organization plans and conducts their daily activities. In basic terms, the steps in a risk management process are:

- Know yourself – your mission and objectives
- Educate yourself, and get input from everyone (experts and those in all aspects of the program)
  - What is going on and what processes are in place
  - Spend extra effort to identify risks, taking a broad view of what could go wrong
- Identify risk rating criteria
  - assess their probability and severity
- Prioritize and identify risks needing abatement plans
- Take small steps, but do something
- Assess the changes, adjust as necessary, and continue the cycle

Although consultants can be helpful, especially if there is limited risk assessment expertise available within the department, they are usually not necessary. Our department had the good fortune of having an Advisory Board member with risk management expertise, and he volunteered to lead the ME faculty and staff, along with representatives of the Industrial and Student Advisory Boards, through a departmental risk assessment. The Student Advisory Board members who participated were primarily upper-level undergraduates and graduate students, and five alumni participated as members of the Industrial Advisory Board. After a discussion of the process and an overview presentation on risk management, we broke into three groups to focus our efforts on identifying the potential risks (anything that could go wrong to keep our program from meeting its objectives) in (1) the undergraduate program and accreditation, (2) graduate and research programs, and (3) departmental administration and operation. Participants wrote their concerns on post it notes which were later organized into affinity groups, compiled into a spreadsheet and sent to all participants for additions and corrections. A faculty committee, with input from the advisory board, worked to rearrange the list into logical groupings (combining things mentioned by more than one of the three groups) and assigned a heading, and created a spreadsheet of risks for our Mechanical Engineering Department.

With the risks identified, the next step was to rate them. Based on their individual perspectives, the ME faculty, staff, and Student Advisory Board members completed risk rating sheets on their own for each risk category in the spreadsheet (for example safety, advising, student academic

performance...). The alumni and Advisory Board members chose not to participate in the risk rating process based on their judgment that they did not have enough familiarity with the detailed operations of the department to give meaningful ratings. An excerpt of the risk rating sheet for the undergraduate program is shown in Table 2. The items in italics are the original statements from the post it notes, and the headings in bold represent the risks that are rated.

Table 2: ME Undergraduate Program Risk Rating Form excerpt

<b>Academic Quality Issues with the UG Program</b>	<b>SEV</b>	<b>OCC</b>
<b>Inadequate quality of service courses will cause problems for students</b>		
<i>Other departments stop offering classes we need</i> <i>Other departments teach required classes poorly</i> <i>Two departments offering the ET courses they vary</i> <i>What if poor instruction of fundamental courses continues</i> <i>Inadequate teaching of technical writing</i> <i>Lack of control over critical core courses taught by others</i> <i>Courses like Statics acting as "discouragers" to qualified ME students</i>		
<b>Issues with courses will lead to some students not meeting outcomes</b>		
<i>Use of equipment by graduate students (negative impact on Ugrad labs)</i> <i>Lack of individual flexibility in Senior Design</i> <i>Missed opportunity of collaboration with EECS in Sr. Design</i> <i>Lack of maintained space for senior lab</i>		
<b>Scheduling issues will cause problems for students</b>		
<i>Unavailability of classes</i> <i>Class sizes too small and students can't get in</i> <i>Class overlapping quarter to quarter</i> <i>Complicated curriculum wrt scheduling</i> <i>Last minute change of scheduling</i>		
<b>Curriculum issues will cause problems for students</b>		
<i>Not enough faculty/student interactions early in program</i> <i>Lack of future plans for (dept commitment to) Engineering Clubs such as SAE, E-Bobcat, etc.</i> <i>Curriculum complexity and inflexibility</i> <i>No clear engineering direction for first year plus</i> <i>Missed opportunity to require that freshmen take introductory courses that help them to meet fellow freshman and a peer mentor</i>		
<b>Workload Constraints will limit faculty effectiveness in UG program</b>		
<i>Lack of time commitments for students</i> <i>Inadequate teacher/student ratio</i> <i>Too much increased research expectations</i> <i>Lack of sr. faculty engaged in undergrad curriculum</i>		
<b>High Workload will limit student effectiveness</b>		
<i>Excessive demands on students</i> <i>Diverse interests leading to overdoing it and stress</i> <i>Not getting enough sleep</i> <i>Too many courses which causes students to become overwhelmed</i>		

The rating method and the definitions of the ratings were reviewed at a department meeting to improve consistency and understanding of the rating categories. Each person rated the severity and probability of occurrence for each risk category that they felt qualified to rate, and the rank was computed as described below:

- SEV = severity or level of impact, i.e. how important is this item or category (1 = low, 2 = medium, 3 = high)
- OCC = likelihood or probability of occurrence that this risk will cause a problem. This area is a combination of whether or not the conditions exist for it to happen, and whether or not we have a sufficient process in place to deal with it to keep it from being a problem. (1 = low, 2 = medium, 3 = high)
- Rank = SEV\*OCC: 6-9 = high = risk management process needed, 3-5 = medium = monitor the situation, 1-2 = low = no current action required

The summary of results for all risk ratings is given in Table 3, with the risks that require a risk management plan shaded in yellow. We decided that it was more relevant to evaluate the percentage of raters that viewed the risk as serious than to average the ratings together, so we established the criterion that if more than 1/3 of the individual raters identified a category as high risk, then we would address it with a risk management plan. The ratings from faculty, staff and students were all given equal weight. Our department is proceeding in order of priority to develop risk management plans for the different risks, and will then implement changes, assess their impact, communicate the actions and impacts, and continue the ongoing process. Through publishing and presenting the results of this process, we hope to assist and encourage other departments to follow a similar risk assessment procedure.

Table 3a: Summary of ME Program Risk Ratings

<b>Perceived &amp; Real Dishonesty</b>	<b>Risk Priority</b>		
	<b>Avg of ratings</b>	<b>Max Rating</b>	<b>% rated 6-9</b>
<b><u>Perceived &amp; Real Dishonesty</u></b>			
P & R Dishonesty in Coursework by Students - Exam level	5	9	63
P & R Dishonesty in Coursework by Students - Homework	4.78	9	56
P & R Dishonesty in Publications by Students	4.50	9	46
P & R Dishonesty in Research by Students	4.57	6	43
P & R Dishonesty in Administrative Issues	3.05	6	15
P & R Dishonesty in Research by Faculty/staff	3.22	9	11
P & R Dishonesty in Publications by Faculty	2.90	6	10
Conflicts of interest for faculty and staff	2.63	6	5
P & R Dishonesty in Coursework by Faculty	2.81	6	4

Table 3b: Summary of ME Program Risk Ratings

Department and Personnel	Risk Priority		
	Avg of ratings	Max Rating	% rated 6-9
Inadequate Resources and support for New Faculty will lead to problems with performance and retention	5.94	9.00	76
Excessive Work Load Expectations will reduce job satisfaction and performance	5.92	9.00	67
Inadequate incentives will cause the program to not meet its objectives	5.20	9.00	60
Inadequate Staffing levels will lead to inability to complete essential tasks	6.00	9.00	60
Inadequate Infrastructure & Facilities will limit our ability to do good work	3.82	9.00	41
Poor faculty/staff morale will lead to problems with performance and retention	4.35	9.00	35
Good faculty will be lost due to P & T issues	2.70	9.00	10
Unclear purchasing guidelines and procedures will lead to mis-spending funds	2.50	6.00	10

Table 3c: Summary of ME Program Risk Ratings

Safety	Risk Priority		
	Avg of ratings	Max Rating	% rated 6-9
<b>Safety Hazards and Accidents</b>			
Risk of Physical Injury to Students	5.30	9.00	60
Risk of Safety Regulatory Violations	4.42	9.00	37
Risk of Senior Design - Safety	4.12	9.00	35
Risk of Chemical Injuries	4.16	9.00	32
Risk of Injury to other people in the facility	3.40	6.00	25
Risk of Equipment Damage	3.60	9.00	15
Risk of Building/Facilities Damage	2.11	6.00	5

Table 3d: Summary of ME Program Risk Ratings

Graduate Program	Risk Priority		
	Avg of ratings	Max Rating	% rated 6-9
<b>Limitations for Future Growth - Graduate Program</b>	6.00	9.00	69
<b>Inadequate Recruiting &amp; Retention</b>			
Inadequate R & R of Faculty	6.46	9.00	85
Inadequate R & R of New Students	4.69	9.00	54
Inadequate R & R of Current Students	5.77	9.00	54
<b>Academic Quality</b>			
Lack of Quality - Student's Research Work	5.00	9.00	46
Inadequate Advising - Faculty constraints	5.31	9.00	46
Lack of Quality Support for Research Work	4.15	6.00	38

Table 3e: Summary of ME Program Risk Ratings

Undergraduate Program	Risk Priority		
	Avg of ratings	Max Rating	% rated 6-9
<b>Academic Quality Issues with the UG Program</b>			
Inadequate quality of service courses will cause problems for students	5.47	9.00	47
Curriculum issues will cause problems for students	4.47	9.00	41
Inadequate attention to assessment will cause accreditation problems	4.10	9.00	40
Scheduling issues will cause problems for students	3.82	9.00	35
Workload Constraints will limit faculty effectiveness in UG program	3.82	9.00	35
Issues with courses will lead to some students not meeting outcomes	4.13	9.00	33
Student effort and ability will be inadequate to meet program outcomes	3.35	6.00	29
Inadequate teaching will lead to some students not meeting outcomes	3.35	9.00	18
ME UG Program issues will lead to a low quality student experience	2.88	6.00	12
High Workload will limit student effectiveness	3.29	9.00	12
Program will decrease in size or be unable to grow	4.00	6.00	29
<b>Recruiting &amp; Retention</b>			
Inadequate Recruiting & Retention of New Students	3.76	9.00	29
Inadequate career support will limit student success in getting jobs or grad school assistantships	3.65	9.00	24
Inadequate diversity of student body will limit the total educational experience	2.88	9.00	18

Table 3f: Summary of ME Program Risk Ratings

Communication & Relations	Risk Priority		
	Avg of ratings	Max Rating	% rated 6-9
<b>Internal Communications &amp; Relations</b>			
Lack of guidelines leading to deficient theses/dissertations	5.60	9.00	60
Poor student advising will cause problems for students	5.18	9.00	53
Poor student monitoring will lead to student misconduct	4.40	9.00	40
Insufficient Student/Staff/Faculty Communication will cause tensions and poor performance	2.76	6.00	6
<b>External Communications &amp; Relations</b>			
Negative press (Plagiarism) will impact our Reputation	5.94	9.00	76
Lack of Publicity or Exposure in Public and Media will cause recruiting problems	5.71	9.00	59
Poor University Relations will cause problems	4.65	9.00	53
Lack of Alumni Relations will decrease alumni support	4.10	9.00	40

## Conclusion

This effort has been beneficial to our department as another way to invite input from everyone in the organization in a non-threatening way in order to uncover areas for improvement. Although the ABET accreditation process is extremely important, it can cause departments to develop a narrow accreditation-based focus and ignore some important aspects that do not fall under the ABET umbrella. We believe taking a broader vision makes for a stronger overall department, and one that is better suited for accreditation. As in any endeavor, success is more likely if you can produce positive effects without too much extra work, so it is important not to create new processes and bureaucracy with a risk management process. We were able to expand our assessment and continuous improvement process to include graduate education issues, administrative issues, other performance related issues, and build most activities into our weekly faculty meetings.

This paper focused on risk assessment, the first step in a risk management process. We have begun the process of monitoring and making changes to reduce risks as appropriate, but details of the risk management process are beyond the scope of this paper.

It is important to note that the time to assess risks is before they occur, so we encourage other departments to conduct similar risk assessments and share the results with the broader community to eventually make all campuses and departments safer and more effective.

## Bibliography

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